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AUTHOR Celestino, Karen Calvert
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ABSTRACT

Success in performing the medical calculations required of nurses demands a competency in basic mathematical skills. This competency cannot be assumed of a number of college students and the nursing student is not an exception to this trend. A test was designed to assess basic mathematical competency and administered to two groups of sophomore nursing students. Major areas of underpreparedness revealed include working with decimals, proportions, and percents. A six-week workshop was structured based on these findings. The results of a medical calculations test given one semester after this assessment program showed an improvement over the results of tests given prior to the inception of this program. (Author)

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Assessing and Remediating Mathematical Underpreparedness in the Nursing Student

Karen Calvert Celestino
Mount Saint Mary College

Running Head: MATHEMATICAL UNDERPREPAREDNESS

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Abstract

Success in performing the medical calculations required of nurses demands a competency in basic mathematical skills. This competency cannot be assumed of a number of college students and the nursing student is not an exception to this trend. A test was designed to assess basic mathematical competency and administered to two groups of sophomore nursing students. Major areas of underpreparedness revealed include working with decimals, proportions, and percents. A six-week workshop was structured based on these findings. The results of a medical calculations test given one semester after this assessment program showed an improvement over the results of tests given prior to the inception of this program.

Introduction

Before speaking on the mathematical underpreparedness of the nursing student, I feel I must admit to you my apprehension about addressing a group of developmental educators such as yourselves. It is only recently that I have become comfortable using the term "developmental educator" to describe myself, entering the field only two years ago as the assistant director of a College Skills Center. Previous to this, however, I spent my graduate school days studying, theoretically, the possibility of laser action from specific molecules--quite a far cry from mathematical underpreparedness. I possessed only limited knowledge about what a skills center was and believed that providing tutoring to students having academic difficulty was the only function of one. It has been a stimulating experience discovering the purpose and diversity of a skills center and realizing that my lack of education courses is not a hindrance to my position while my broad science and mathematics education is an enormous asset to it. My background provides me with a realization of the paramount importance of basic mathematical skills--an insight which I find myself often relaying to students who question this importance in their lives and future professions.

It is this realization that sparked and maintains my interest in the assessment and instruction program I am about to describe for you--a program initiated at Mount Saint Mary College to assess and remediate mathematical underpreparedness in the nursing student.

I'd like to talk about the reasons for the inception of this program, exactly what the program consists of, what we have been able to achieve and the implications of what we have found.

I'd like to begin with a quote from the Journal of Nursing Education in which J. Yess states

> the ability to analyze and apply scientific principles pertinent to the nursing profession depends on mathematical aptitude.

It is evident that success in performing the medical calculations required of nurses such as computing intravenous flow rates or drug dosages demands a competency in basic mathematical skills. Unfortunately, many studies indicate that basic math competency cannot be assumed of a number of college students and the nursing student is not excluded from this group.

The faculty of the Nursing Division at Mount Saint Mary College noticed a decline in the passing rate of nursing students taking a medical calculations exam (a test which all first semester junior nursing students enrolled in Nursing II must pass). The nursing instructors were spending a good part of the semester on medical calculations instead of on other nursing topics which were planned to be discussed.

This progressive decline in performance was questions by a discouraged and frustrated Nursing Division who hypothesized that the decline might indeed by attributable to the trend being seen among many college students--weak math skills.

The Division requested that we design a math proficiency exam which would test for those math competencies needed to perform medical calculations and to provide some type of in-

structional program for those students who, as revealed by this exam, were found to be mathematically underprepared. The exam was to be administered one semester before students enter their first year of clinical study so as to allow time for the remediation of deficiencies prior to taking the medical calculations exam.

Design of Math Proficiency Exam

It was necessary to examine the junior medical calculations exam in order to further educate myself as to what math skills are needed to perform medical calculations and to then design a math proficiency exam specifically for nursing students.

The medical calculations test requires students to express metric quantities in metric equivalents, to calculate how much of an available dosage of a drug is needed for a particular ordered dosage and to calculate intravenous flow rates.

It was immediately apparent--and my background in chemistry was quite helpful in making this determination-- hat the nursing student must be proficient in performing all basic mathematical computations and in some basic algebraic manipulations. These include:

1) working with fraction and decimal numbers;
2) understanding and applying the concept of percent;
3) setting up and solving proportions;
4) using exponential notation;
5) solving simple linear equations;

6) basic problem-solving techniques.

A 45-question multiple choice exam was designed to assess these competencies and structured so that a student could not pass with major deficiencies in any one of the above areas.

This exam is unique in that it is tailored specifically for the nursing student. It goes beyond the skills usually tested for on a basic arithmetic skills test in that exponential notation and introductory algebra techniques are included. It also includes applied proportion problems which are pertinent to the nursing profession.

% Non-Competence As Revealed By Exam

The degree of mathematical underpreparedness revealed by the testing of two populations of Nursing I students at Mount Saint Mary College (the class of 1986 and 1987 nursing students) is illustrated in Appendix I.

Note that population I (class of 1986 nursing students) was tested in three separate groups (Groups A, B, and C on the Appendix). Groups B and C are nursing students, who, for a few different reasons which I will discuss later, were not in Nursing I at the time of the test but who were to enroll in Nursing II the following semester.

Of the 66 students initially tested in March of 1984 (Group A), 29% were determined to be non-competent--almost one-third of the students tested. These students were required to attend a 9-hour instructional workshop or to receive individual tutoring and were retested one month later. Following the first retest,

18% of the initial 66 students were not yet competent and after the second and final retest, 11% had still failed to demonstrate competency.

It is interesting to compare the testing results for Group A to that of Groups B and C. A majority of Group B were not in Nursing I at the time of testing due to failing Nursing I the previous year and taking it over during the Fall of 1983. More than half of these students were found to be non-competent by the initial test. This poor performance on the math proficiency exam may be due to what is also indicated by their performance in Nursing I--they are a weaker group of students, academically.

An astounding 52%, more than half, of the second population of sophomore nursing students, did not demonstrate proficiency on the initial test. These students attended the 9-hour instructional workshop or received individualized tutoring and after the first retest, 15% are still not proficient in the skills tested for.

This assessment of mathematical underpreparedness in two populations of Nursing I students may indicate significant differences between the two groups since 52% of population II students were found to be non-competent by the initial test as compared to 29% of the first testing group. Both numbers, however, illustrate an alarming degree of mathematical underpreparedness in sophomore nursing students.

A comparison of the testing dates of the math proficiency exam for these two populations of nursing students may account for some of the difference in the initial failing rate for the two groups. Population I students were informed at the end of

January that the math proficiency exam would be administered to them at the end of March. During the two month period prior to the testing date, the skills center offered a mathematical computations workshop which, although, not designed specifically for nursing students, was available for them to participate in. Approximately 1/5 of Group A students participated to some degree. Population II students, however, were informed in November that they would be tested at the end of January. Although this group had all of January Interim to spend independently studying, they did not have the same opportunity to attend a computations workshop.

There is, however, another indication of more significant differences between the two populations. All entering freshmen at Mount Saint Mary take screening exams to determine placement in courses. In general, the Class of 1987 students did significantly worse than the Class of 1986 students. This may indicate, along with the results of the math proficiency exam, that Population II students are indeed a weaker group.

Major Areas of Mathematical Underpreparedness as Revealed By Math Proficiency Exam

The major areas of mathematical underpreparedness exhibited by the nursing students taking the math proficiency exam are shown in Appendix II.

Finding decimal, fraction and percent equivalents, excluding finding the decimal equivalent of a fraction, presented the greatest difficulty to both populations of nursing students with a mean of 20% of population I students and a mean of 40% of

population II students answering these questions incorrectly.

The questions involving division of decimal numbers were on the average answered incorrectly by 16% of population I students and 28% of population II students.

Questions requiring students to set up and solve proportions were answered incorrectly by a mean of 17% of population I students and 21% of population II students.

Word problems involving percents and proportions were areas which the students also had a great deal of difficulty with.

Questions requiring students to perform basic algebraic manipulations and to work with numbers in exponential notation were not a major difficulty to most students which is probably attributable to the fact that these students have used these skills most recently in chemistry and physics courses.

9-Hour Instructional Workshop

I'd like to briefly describe the structure and philosophy of the 9-hour workshop which all students who failed the initial test were required to attend. Each session of the workshop consisted of approximately one hour of instruction followed by a half hour of independent problem-solving. The instruction period focused on the understanding and reasoning upon which all the rules and formulae that we were taught in grammar school and junior high are based--thus taking advantage of the cognitive abilities of the college student and de-emphasizing the role of memorization in mathematics.

Characteristics of Mathematical Underpreparedness as Revealed by the Workshop

I would like to share with you just a few of my observations of the nursing students who attended the mathematical computations workshop. Much of what I observed in these students I have also observed in the other mathematically underprepared students who have participated in my workshops.

The difficulty with decimal division was two-fold. In addition to not knowing when the decimal point in the divisor and dividend had to be moved, many students did not know which number was the divisor and which number was the dividend.

Finding the percent equivalent of a decimal number or of a fraction and working with percents posed much difficulty due to a lack of understanding of the concept of percent and not realizing its equivalence to decimals and fractions.

My conversations with mathematically underprepared nursing students revealed an overemphasis on the importance of formulae and rules and an underemphasis of the understanding of concepts and processes. The students, however, were very receptive to gaining this understanding and downplaying the importance of rules.

One important observation of the mathematically underprepared nursing student was the lack of insight into the significance of basic math skills in the nursing profession. This, however, is probably attributable to the fact that these students were just beginning their sequence of nursing courses.

Effects of Program on the Results of the Medical Calculations Test

Has the program fulfilled its purpose? Has it strengthened the mathematical abilities essential for success on the medical calculations test?

This program is in its infancy. We have only a preliminary idea of the answers to these questions considering that only population I students have taken the medical calculations test, population II students will be tested this coming fall.

A comparison of the passing rate on the medical calculations test for two groups of junior nursing students is shown in Appendix III.

Population III represents Class of 1985 junior nursing students who were not tested under our program prior to taking the medical calculations test. The second results shown are those of population I nursing students, the first group to go through our assessment and remediation program. Only 68%, about 2/3 of population III passed on the initial try. Three retests were then necessary before all students met the course requirement of passing this test.

In comparison, almost 80% of population I students passed this test on the initial try and 97% passed following the first retest.

One member of the nursing department indicated that (in reference to population I students) the instructors of Nursing II could finally devote most of the semester to nursing topics instead of spending a majority of the semester on medical calculations, as it was necessary to do in previous years.

Data on the medical calculations testing of population II students and future classes of nursing students are necessary before definitely attributing this improvement to our assessment and instruction program. Perhaps population I students are a better group of students. However, we do believe that those students entering Nursing II following our program are proficient in basic mathematical skills and better prepared to perform medical calculations.

Implications of these Results

The results presented here have enormous implications for a college-wide proficiency testing program and curriculum development--it is certainly suggested that college-wide testing in basic mathematical skills is a necessity. Mount Saint Mary College began testing incoming freshmen in basic arithmetic skills this past fall and a basic math course modeled on the one we piloted has just been added to the curriculum for the Fall of 1985 for those students who are not proficient in these skills. The mathematically underprepared student must not be ignored by college communities--this type of student is a reality and must be given the opportunity to become proficient in these basic skills.

ASSESSMENT OF MATHEMATICAL UNDERPREPAREDNESS

Population I

	Date of Test	# of Students Tested	# of Students Who Failed	% Non-Competent *	% of Total
GROUP A	3-26-84	66	19	29%	29%
	4-26-84	19 (retest 1)	12	63%	18%
	9-4-84	9 (retest 2)	4	44%	11%
GROUP B	4-26-84	14	8	57%	57%
	9-4-84	6 (retest 1)	3	50%	36%
GROUP C	9-4-84	1	1	100%	100%

Population II

	Date of Test	# of Students Tested	# of Students Who Failed	% Non-Competent *	% of Total
GROUP D	1-30-85	65	34	52%	52%
	4-11-85	33 (retest 1)	9	27%	15%

** Passing grade - 84%*

MAJOR AREAS OF MATHEMATICAL UNDERPREPAREDNESS

	Mean % Answering Incorrectly	
AREA	Population I	Population II
Finding Decimal Fraction and Percent Equivalents *	20%	40%
Division Involving Decimals	16	28
Setting Up and Solving Proportions	17	21
Word Problems	21	19

* *Excluding finding the decimal equivalent of fractions*

NURSING II

DRUG CALCULATION TEST RESULTS

Population III

Date of Test	# of Students Tested	# of Students Who Failed	% Who Failed	% of Total
Fall '83	76	25	32%	32%
	25 (retest 1)	14	56%	18%
	14 (retest 2)	3	21%	4%
	3 (retest 3)	0	0%	0%

Population I

Date of Test	# of Students Tested	# of Students Who Failed	% Who Failed	% of Total
Fall '84	72	15 *	21%	21%
	15 (retest 1)	2	13%	3%

** 6 of the students who passed, failed the math proficiency test*